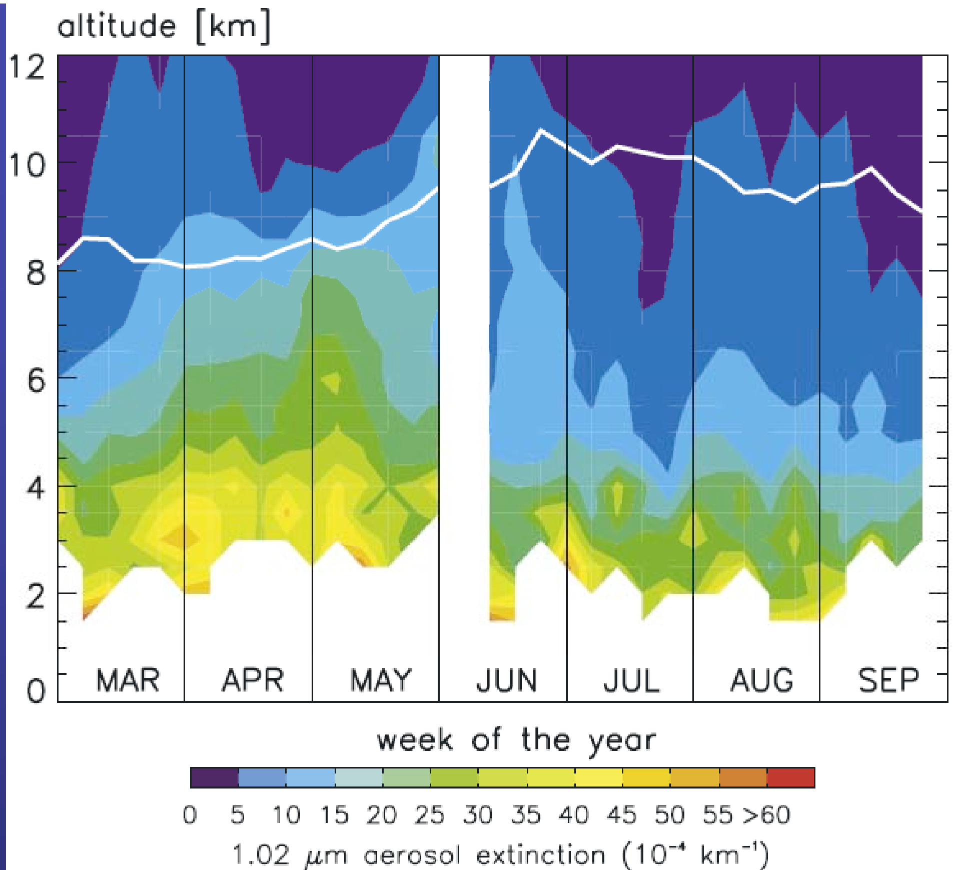
Vertical Structure of Arctic Haze

Chuck Brock, NOAA ESRL

- In situ data from U. of Washington airborne programs in 1980s
- Lidar image of haze structure
- Implications for research goals
- NOAA research plans in 2008

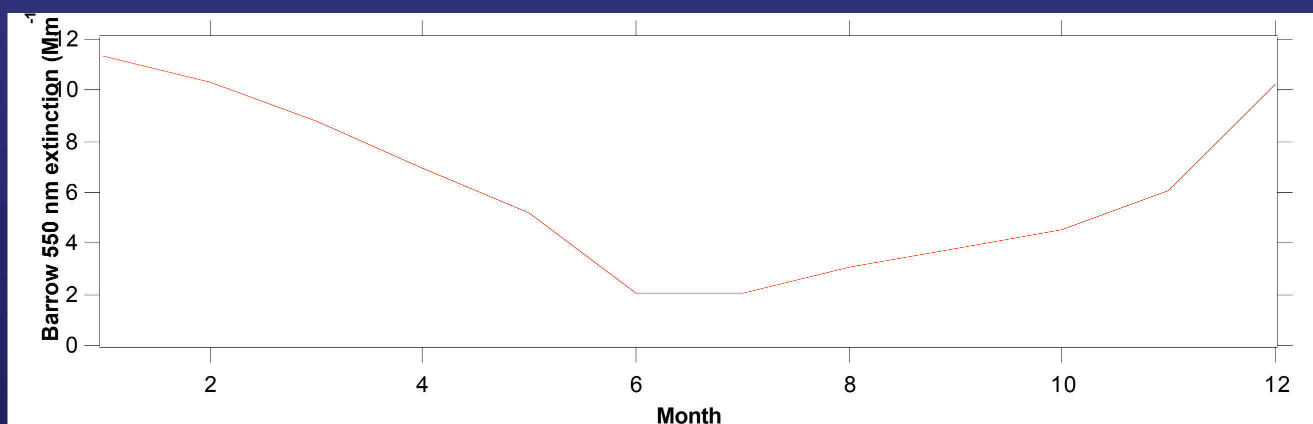


Treffeisen et al.

SAGE II observations suggest maximum vertical extent in March-April.

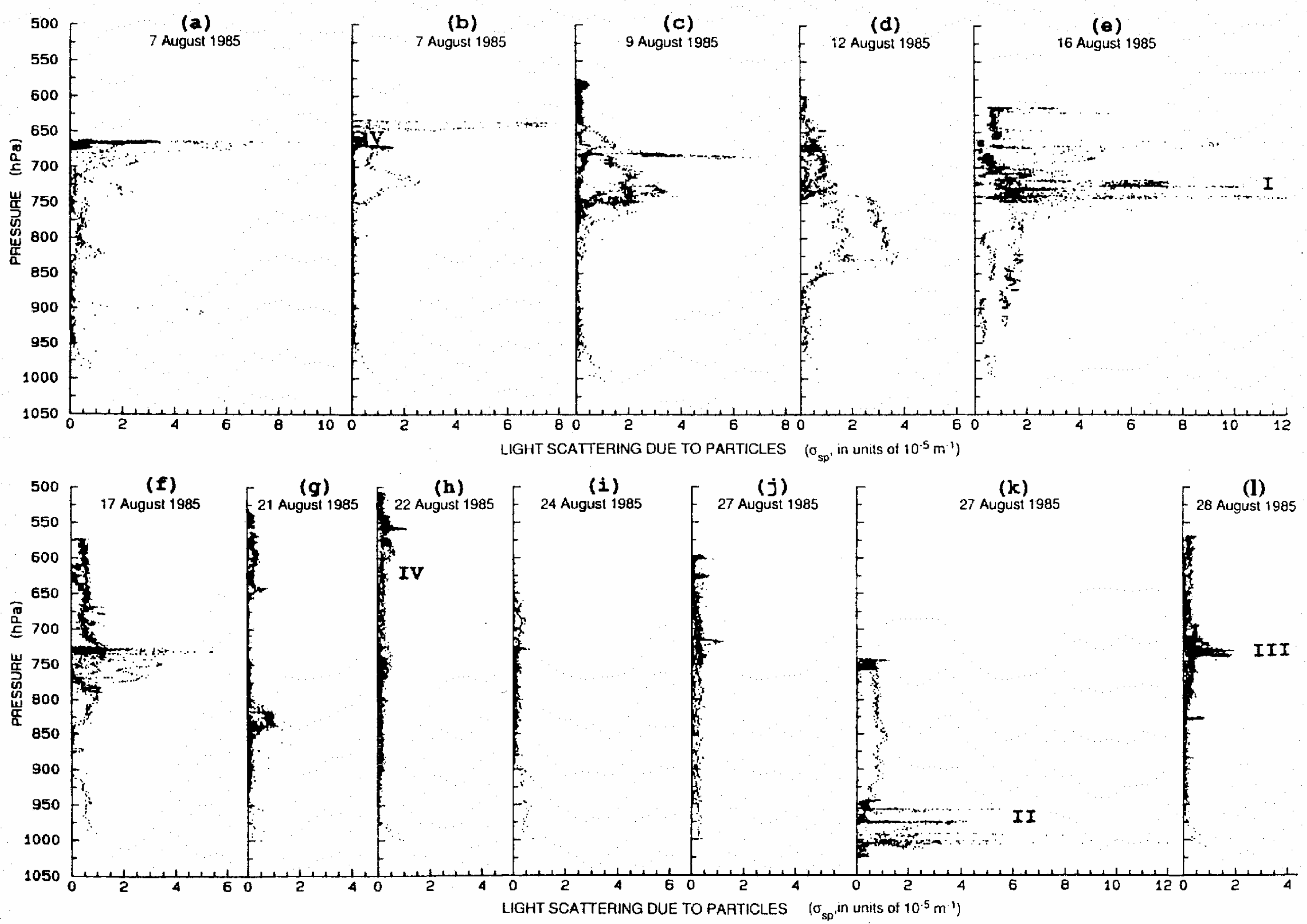
Similar cycle for sun/moon/ star extinction optical at Ny- Alesund (Herber et al.)

Need CALIPSO analysis?!

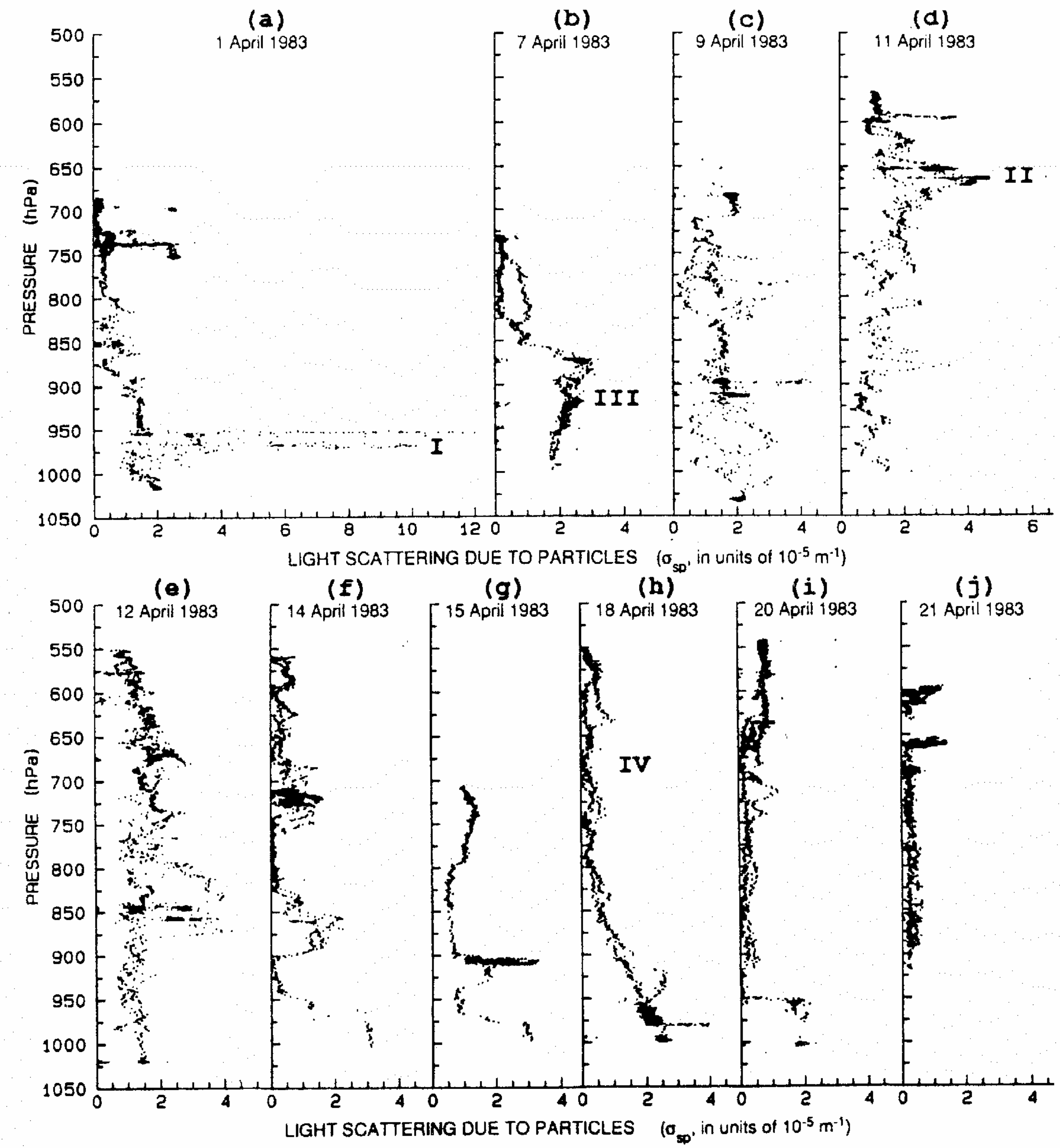


Quinn et al.--surface observations show Jan-Feb max at Barrow

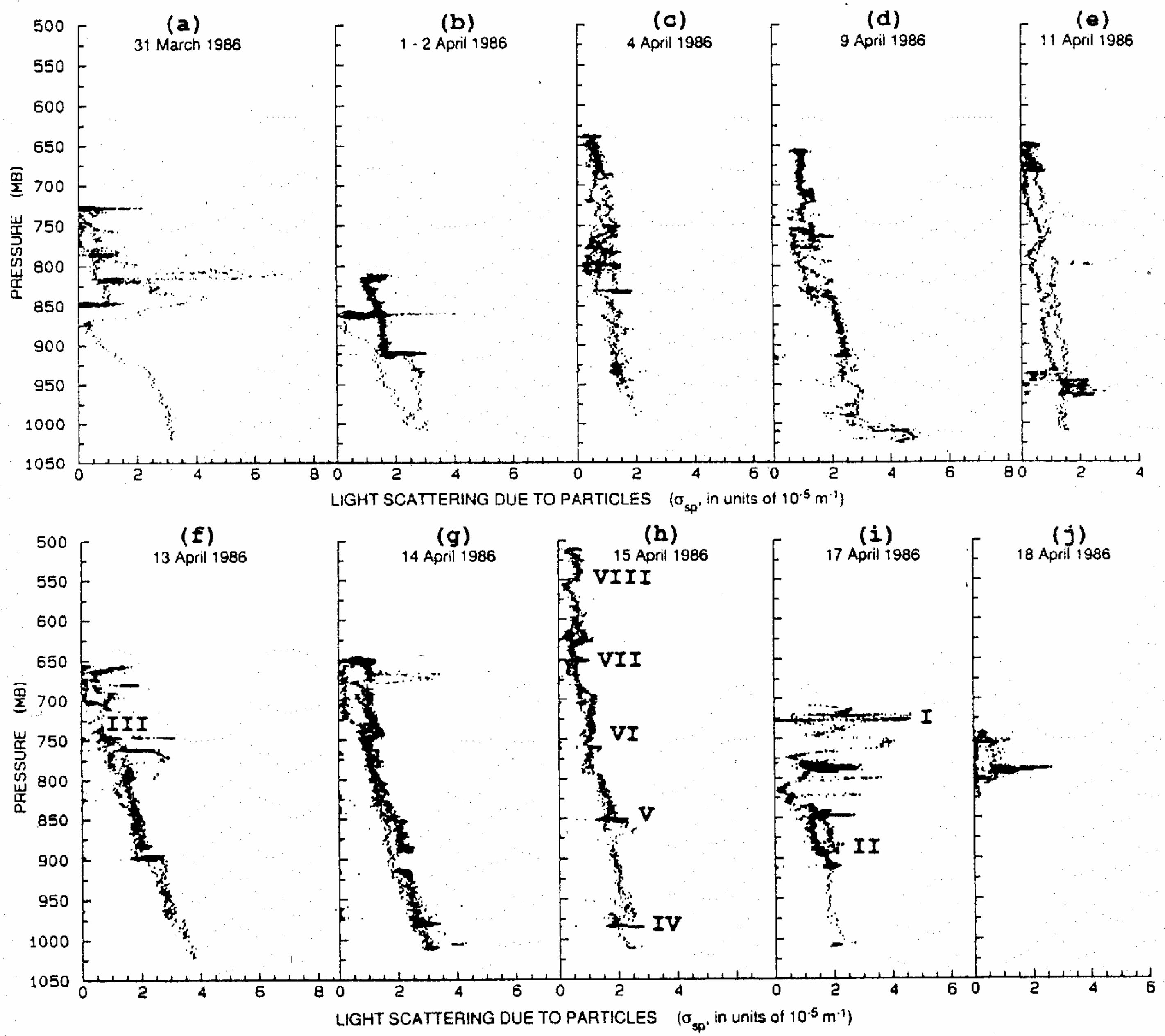
August 1985: Dense summertime smoke layers aloft

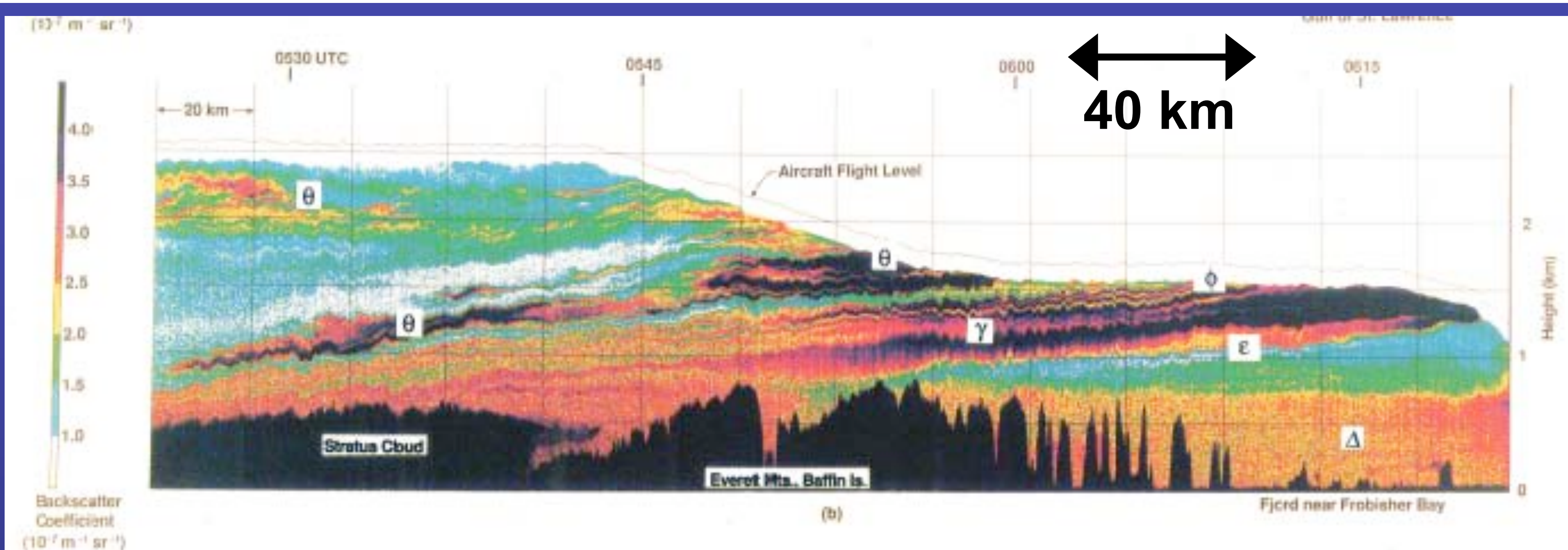


April 1983: Dense pollution layers aloft



April 1986: Layers aloft, more diffuse near surface





Lidar images in April 1986:

- Extremely laminar transport
- Sloping thin layers
- Strong gradients vertically & horizontally
- Frequently decoupled surface layer
- Highest concentrations may be aloft
- Diamond dust and stratus near surface

Vertical Structure of Arctic Haze: Implications for Research Plans

- Surface sites are often decoupled from most dense hazes—inferring indirect effects based on surface aerosol properties is hazardous

- What links layers aloft to climate?
  - ¬ Direct radiative and thermal effects
  - ¬ Cloud modification (indirect effects)
  - ¬ Deposition to surface

- What unique information can *in situ* measurements provide?

In situ measurements can focus on detailed characteristics of layers and clouds and the processes that link them to climate:

- Evaluate vertical structure of direct radiative properties of hazes
- Examine aerosol/cloud interactions, including IN composition, soot incorporation
- Measure in-situ cloud properties over surface site(s)
- Examine properties of aerosol aloft to help evaluate sources and likely climate effects

NOAA Airborne Research Plans for IPY

- NOAA will *likely* participate in an airborne field program in spring 2008
- P-3 research aircraft
- April 2008 time frame
- North American Arctic
- Possible bases include Fairbanks, others?

Methodolgies

•Quantify aerosol vis. optical properties (extinction, f(rh), absorption) as f(altitude)

•Quantify aerosol composition, including soot number, mass, mixing state

•Test for closure between aerosol properties and spectrally resolved irradiance measurements, visible to near-IR

•Look for aerosol effect on cloud μphysics [cloud number and size as *f(particle number, chemistry)*] within stratiform clouds forming within haze layers

Methodolgies continued

- Examine clear-air "diamond-dust" ice crystal properties in surface inversion
- Study artificial cloud particles (*via* ice nuclei chamber) for incorporation of soot
- Use trace gas measurements and transport simulations to determine source regions
- Use single particle composition to identify specific contributors (e.g., smelters)

Summary

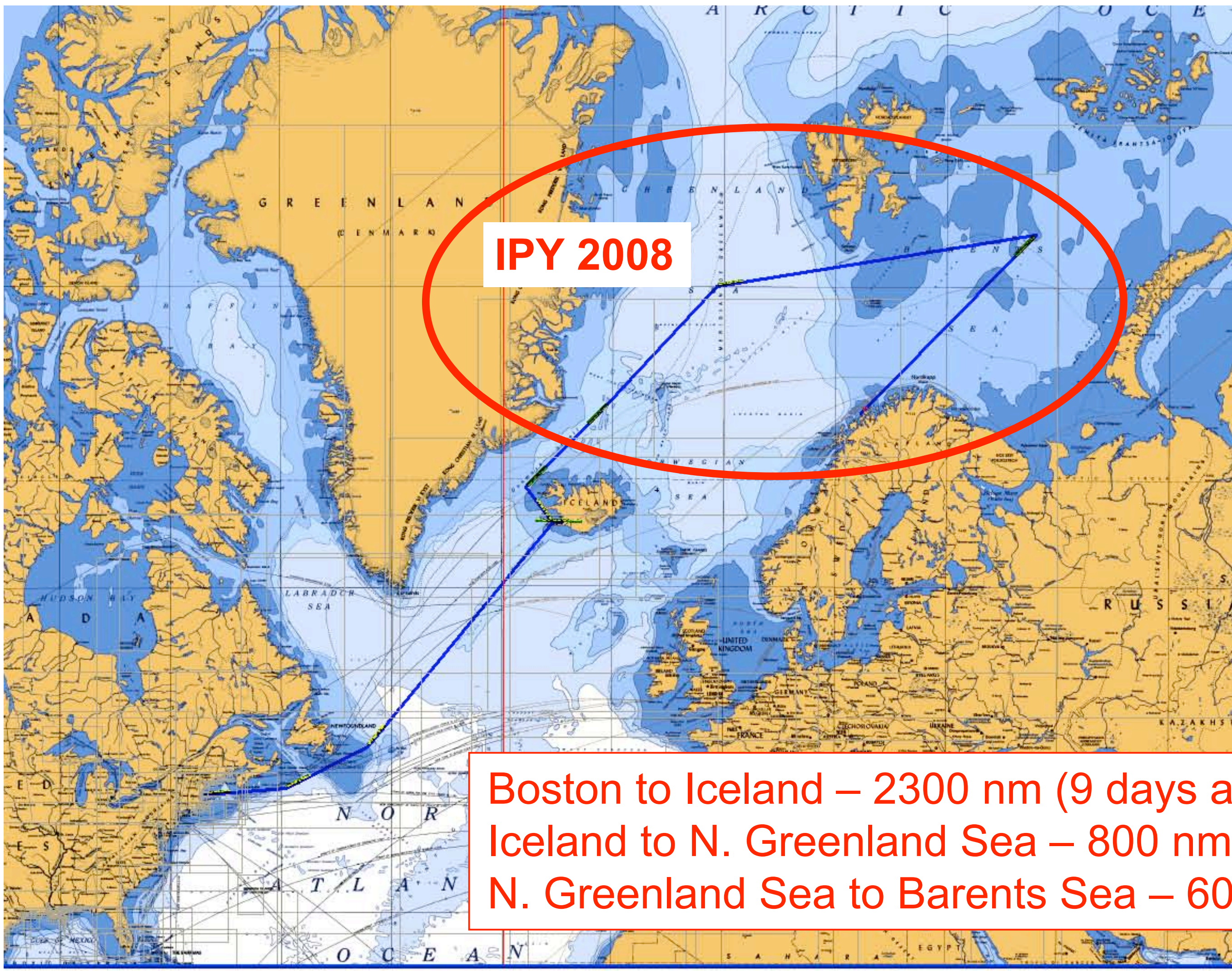
Understanding complex direct and indirect processes in a vertically stratified environment requires a combination of approaches:

- surface observations (including deposition and snow/ice characteristics)
- remote sensing from surface, space, and air
- airborne in situ measurements
- radiative, chemical, microphsyical and transport modeling
- emissions/source evaluation

Proposed NOAA 2008 Field Study

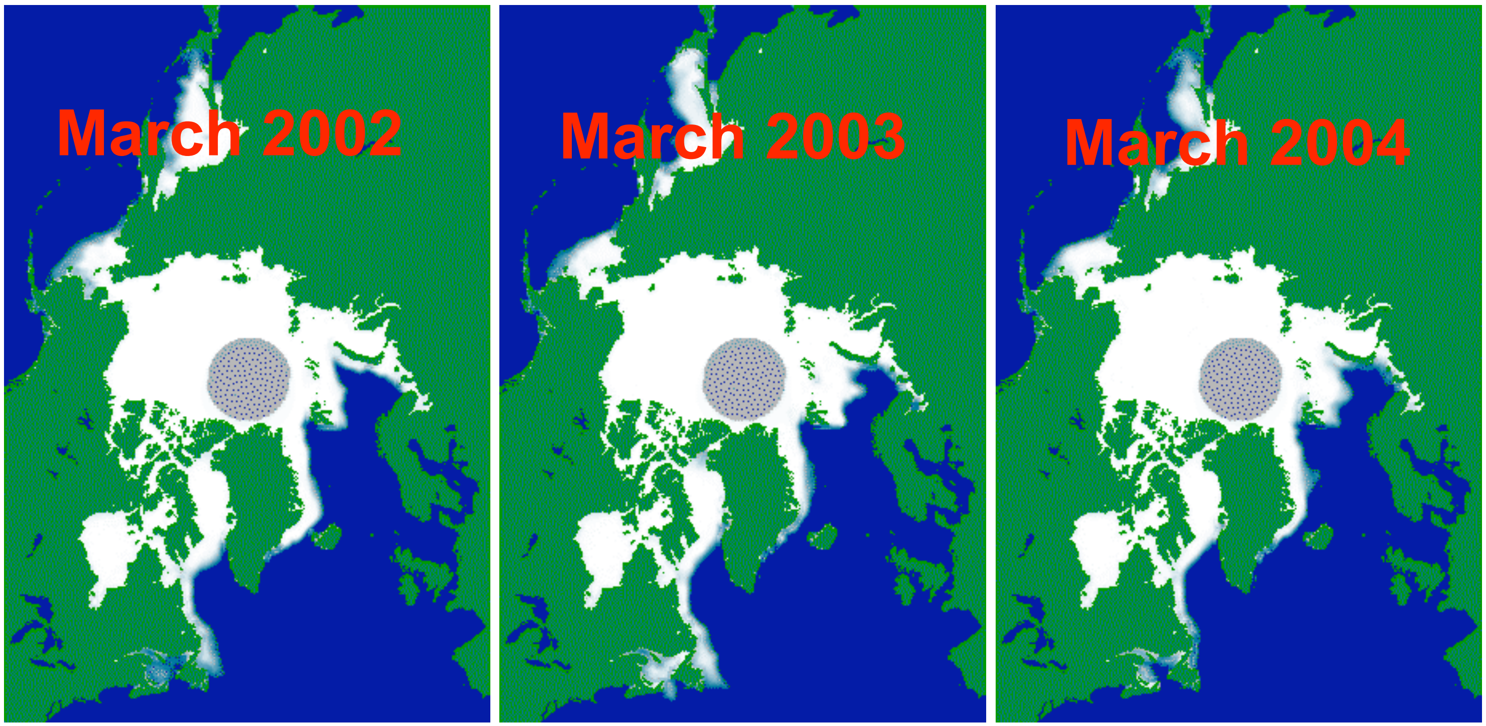
International Polar Year Climate Study

March – April 2008



Boston to Iceland – 2300 nm (9 days at 11 knots)
Iceland to N. Greenland Sea – 800 nm
N. Greenland Sea to Barents Sea – 600 nm

Ice Extent



Proposed NOAA 2008 Field Study
International Polar Year Climate Study
March – April 2008

Focus will be on:

- Springtime sources and transport of pollutants to the Arctic
- Evolution of aerosol and gases into and within the Arctic
- Aerosol – climate interactions